Fictitious ISO Component of Moment Tensor Due to Erroneous Depth

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That an erroneous depth determination can lead to a moment tensor with a fictitious explosive/implosive (ISO) component is explained in Figure 1, below. A earthquake at 5 km depth (green square) and with no ISO component is observed by two stations (red) that subtend 90° of the focal sphere, which hypothetically align exactly with the nodal planes of a normal fault. All stations located between these two stations will be in the same quadrant of the focal sphere and will experience ground motion of the same sign. If the earthquake were to be mislocated at 4 km depth (purple square), then the angle subtended is greater than 90° and, consequently, covers more than one quadrant. One would expect some stations located between the red stations to have reversed ground motion, yet according to the scenario, none is observed. In order to fit the data, a fictitious ISO component must be introduced to "widen" the upward facing lobe of the radiation pattern.

The reverse situation applies if the earthquake is erroneously located too deep. A fictitious ISO component must be introduced to "narrow" the upward facing lobe.

In the extreme cases of the earthquake being mislocated just below the Earth's surface, the subtended angle widens to 180° . One would expect to observe half of the intervening stations to be reversed. Consequently, the amount if ISO component that must be added to the data needs be comparable in size to the moment of the earthquake. The ISO error cannot be said to be "minor" in this case!

We expect that the amplitude of the ISO component will depend, to some degree, on the details of the station configuration.

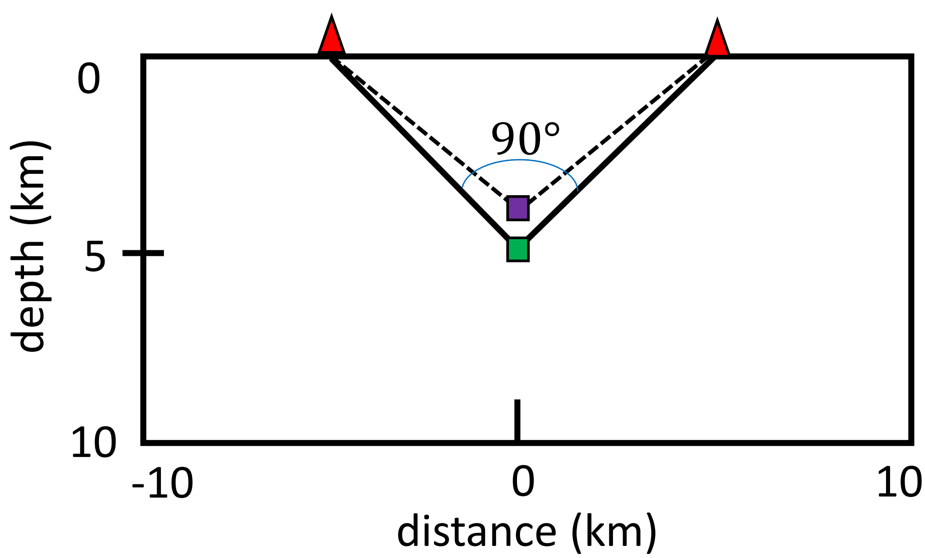

Fig. 1. Schematic diagram of earthquake.

In the test scenario, an earthquake occurs at position $(x, y, z) = (0, 0, 5 \text{ km})$. Vertical component P-wave amplitudes are observed on a "local" array of seismometers (Figure 2). Ray paths are assumed to be straight lines. A linear inversion is used to determine the moment tensor **M**.

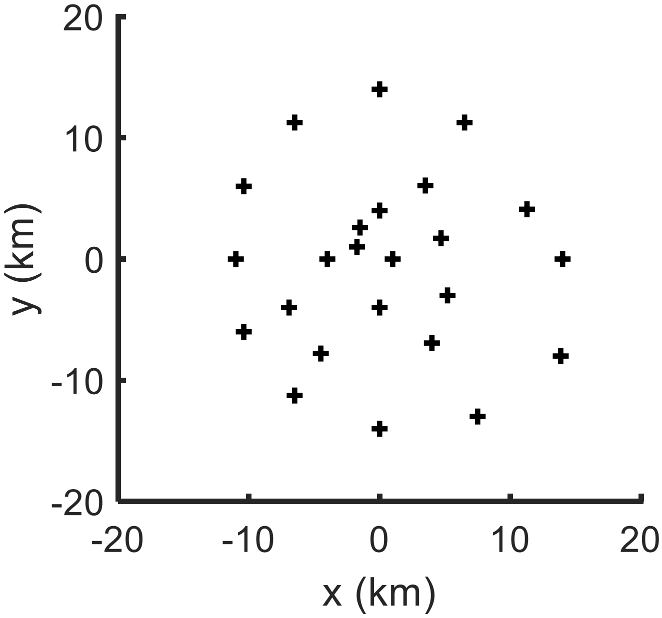

Fig. 2. Station locations used in the test scenario.

In the test scenario, an earthquake occurs at position $(x, y, z) = (0, 0, 5 \text{ km})$. Vertical component P-wave amplitudes are observed on a "local" array of seismometers (Figure 2). A variety of fault orientations are tested, starting with a vertical dip-slip fault ($\theta = 0$), and then rotating it in the (x, z) plane. The size of the ISO component is quantified by the trace of the moment tensor **M** , divided by its largest eigenvalue λ^{max} (Figure 3).

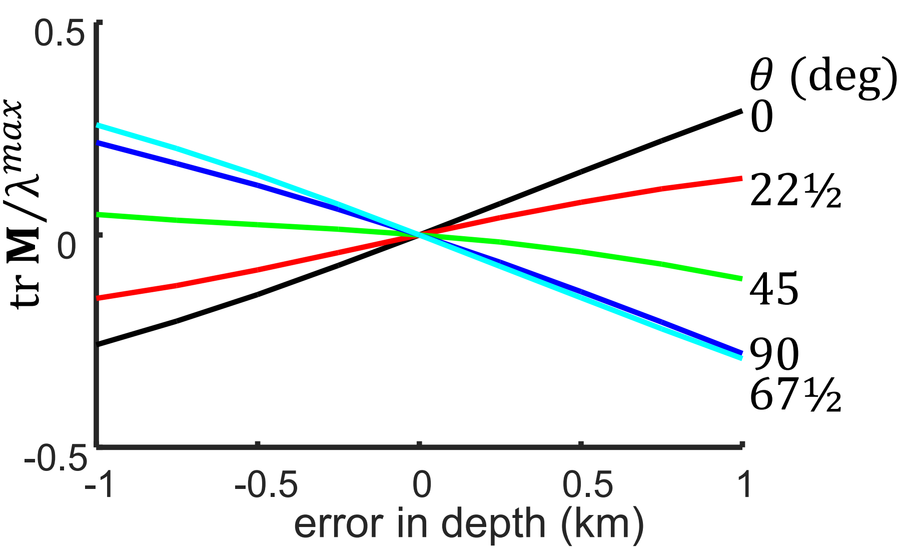

Fig. 3. Results of the simulation. Fictitious ISO components in the 0.1-0.2 range are common.